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28 October, 1999

ADST II
DELIVERY ORDER

FINAL REPORT
CDRL AB01

FOR

BATTLE COMMAND VEHICLE/ COMMANDER'S COMMAND & CONTROL SUITE CONCEPT EVALUATION PROGRAM (BCV/CDR'S C2S CEP) EXPERIMENT

DO # 118

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13. ABSTRACT ***(Maximum 200 Words)*** This report documents the work performed for the Battle Command Vehicle/Commander's Command & Control Suite Concept Evaluation Program (BCV/CDR's C2S CEP) experiment. The efforts under this Delivery Order were in accordance with the ADST II SOW for BCV/CDR's C2S CEP Experiment (Document AMSTI-99-W055, version 1.0, dated 28 April 1999). The BCV/CDR's C2S CEP Experiment was sponsored by Fort Knox's Mounted Maneuver Battlespace Lab (MMBL), and falls within the Advanced Concepts and Requirements (ACR) domain.

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1. SCOPE

This report documents the work performed for the Battle Command Vehicle/Commander's Command & Control Suite Concept Evaluation Program (BCV/CDR's C2S CEP) experiment. The efforts under this Delivery Order were in accordance with the ADST II SOW for BCV/CDR's C2S CEP Experiment (Document AMSTI-99-W055, version 1.0, dated 28 April 1999). The BCV/CDR's C2S CEP Experiment was sponsored by Fort Knox's Mounted Maneuver Battlespace Lab (MMBL), and falls within the Advanced Concepts and Requirements (ACR) domain.

1.1 Background

During the Task Force XXI exercise conducted at the National Training Center in 1997, a Command, Control and Communications (C3) Assessment for the Battle Command Vehicles (BCVs) was accomplished. The overall concept was to examine different size forces, from individual soldier to Brigade level, who were equipped with a series of digitized improvements in battlefield information management and see how they affected the ability of the force to accomplish the mission. The prototype BCVs were among the systems reviewed.

This Delivery Order provided ADST II support for the MMBL, in conjunction with the TSM for Force XXI Future Battle Command Brigade & Below (FBCB2), in the conduct of a Battle Command Vehicle/Commander's Command & Control Suite Concept Evaluation Program (BCV/CDR's C2S CEP) Experiment. The purpose of the experiment was to gain insight into the utility and plausibility of locating an operations assistant in the Battle Command Vehicle to operate and facilitate use of FBCB2 to enhance situational awareness and command and control.

1.2 Objectives

The objectives of this effort were as follows:

a) Assess the requirements for low-cost add on installation kits to upgrade the necessary manned simulators (M1, M2, etc.) with additional FBCB2 capabilities.

b) Assess the use of an operations specialist as an assistant to the commander in managing information and executing Command and Control on his combat system.

c) Ensure that any Command and Control equipment or personnel changes within a Battle Command Vehicle do not deter or degrade weapon system operational capabilities.

1.3 Assumptions

1.3.1 General Assumptions

The following assumptions were made in the planning of the experiment:

a) Maximize use will be made of existing ADST II assets whenever possible.

b) The program schedule set by the MMBL will not be waived.

c) All hardware and software products will be Year 2000 compliant.

1.3.2 Government Furnished Property/Information (GFP/GFI)

The following GFP/GFI is equipment not currently part of the ADST II property inventory or is data/information not currently contained in the ADST II Master Library. This GFP/GFI was provided by the Government to support the execution of this Delivery Order.

a) Scenario descriptions.

b) Requirements for software functionality modifications.

c) FBCB2 equipment sets (via TRW)

1.4 Security Classification Level

This effort was conducted at the UNCLASSIFIED level.

2. APPLICABLE DOCUMENTS

2.1 Government

a) Battle Lab Experimentation Plan (BLEP) for BCV/CDR's C2S CEP.

b) ADST II SOW for BCV/CDR's C2S CEP Experiment (Document AMSTI-99-W055, version 1.0, dated 28 April 1999.

2.2 Non-Government

a) None.

3. TASKS

ADST II Delivery Orders (DOs) involve tasking pertinent to the promotion, development and application of distributed synthetic environments. The life cycle of a synthetic environment (SE) includes a planning and analysis stage, development activities to prepare equipment and personnel for applications of the SE, activities associated with conducting an SE application, and application follow-up activities such as data analysis and reporting. Table 3-1 provides an overview of the tasking for each of the four phases of the synthetic environment lifecycle for this effort.

WS Para. Ref.	Phase	Overview of Tasks
3.1.1	Planning & Analysis	Provide general experiment, data collection, and scenario planning support. Plan for the integration of FBCB2 into M1A1 & M1A2 simulators.
3.1.2	Development and Modification	Modify, configure, and integrate the necessary simulation systems for use by exercise participants during the experiment.
3.1.3	Application Support	Support Training, Pilot Test, and Execution of the experiment.
3.1.4	Follow-On Support	Conduct data reduction, site reconfiguration, and documentation activities.

Table 3-1. Tasking Overview

3.1 Engineering

3.1.1 Planning & Analysis

3.1.1.1 Experiment Planning and Coordination Activities

The ADST II team provided general support for the planning and coordination of the experiment, including meeting support and overall experimental systems integration. This included development of a detailed system diagram, identification of necessary modifications to existing M1A1 and M1A2 simulators to support integration of the FBCB2 equipment, and identification of other equipment and systems necessary to support experiment needs.

3.1.1.2 Scenario Development

The ADST II team provided the Government with support in developing training and test scenarios for this effort, including support at government called scenario meetings. The Government provided the actual scenario requirements.

3.1.1.3 Data Collection

The ADST II team analyzed the data collection requirements for all experiment simulation systems, and derived methods for recording, compiling, and delivering the required data.

3.1.2 Development, Modification and Configuration Activities

The ADST II team modified, configured, and integrated the MWTB and other assets necessary for use in the experiment described in the BCV/CDR's C2S CEP BLEP, as determined during planning, analysis, and technical interchange meetings. The overall system that resulted is shown in Figure 3-2 below.

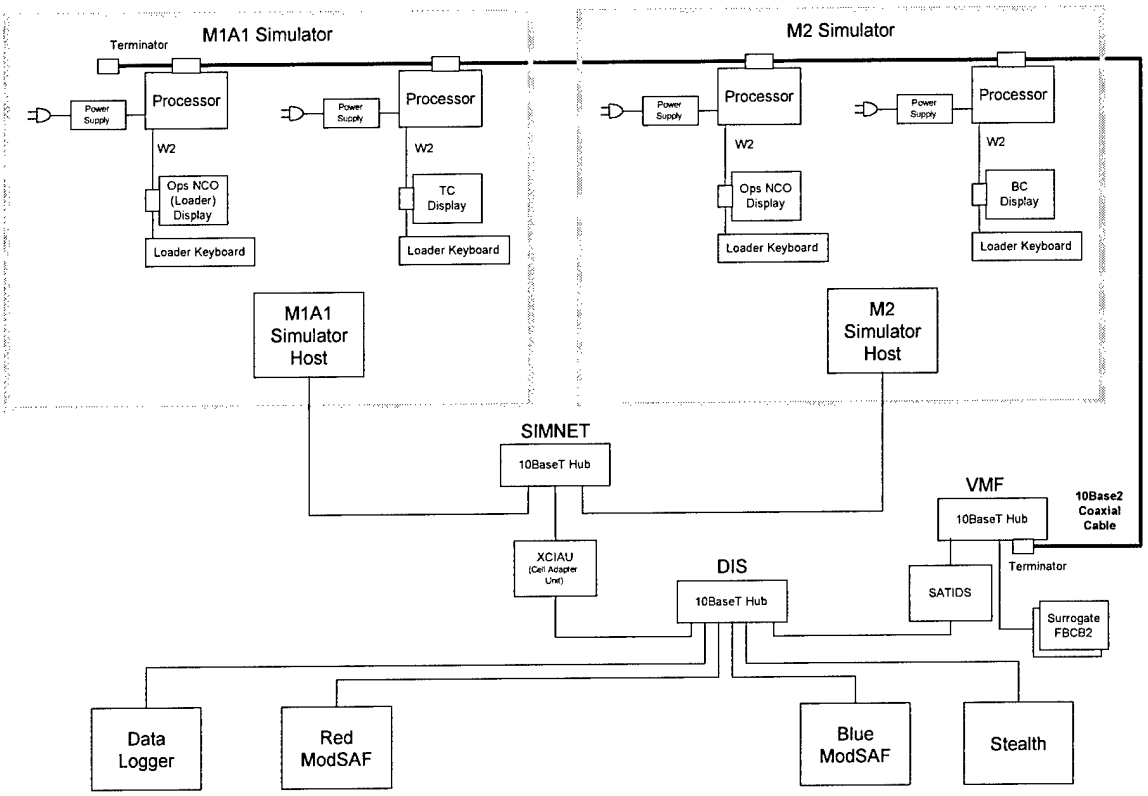

Figure 3-2. Simulation Block Diagram

3.1.2.1 Future Battle Command Brigade & Below (FBCB2)

The ADST II team, supported by engineers from TRW, integrated the FBCB2 hardware and software with the M1 and M2 simulators and the other simulation equipment shown in Figure 3-2.

3.1.2.2 Manned Simulators and Mockup

The ADST II team modified the M1 and M2 simulators as required to mount the loaned FBCB2 devices. Two were mounted in each simulator with independent controls; one at the commander's station and the other at the NCO's support station. This required some cutting into the crew shells. Figures 3-3 and 3-4 show the mounting of the FBCB2 displays in the M2; Figures 3-5 and 3-6 show the M1 mountings.

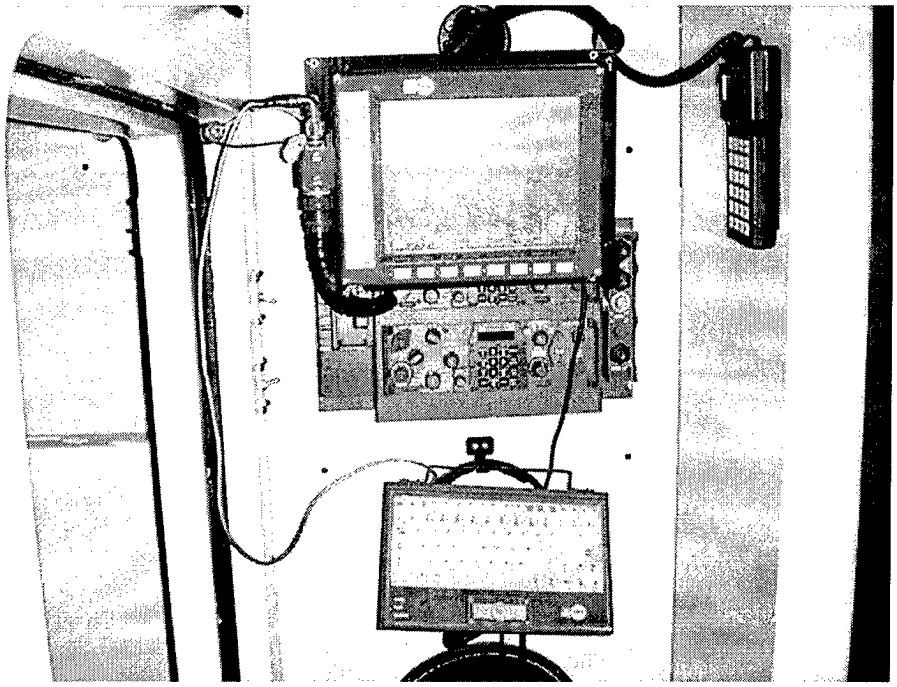

Figure 3-3. M2 Support Position

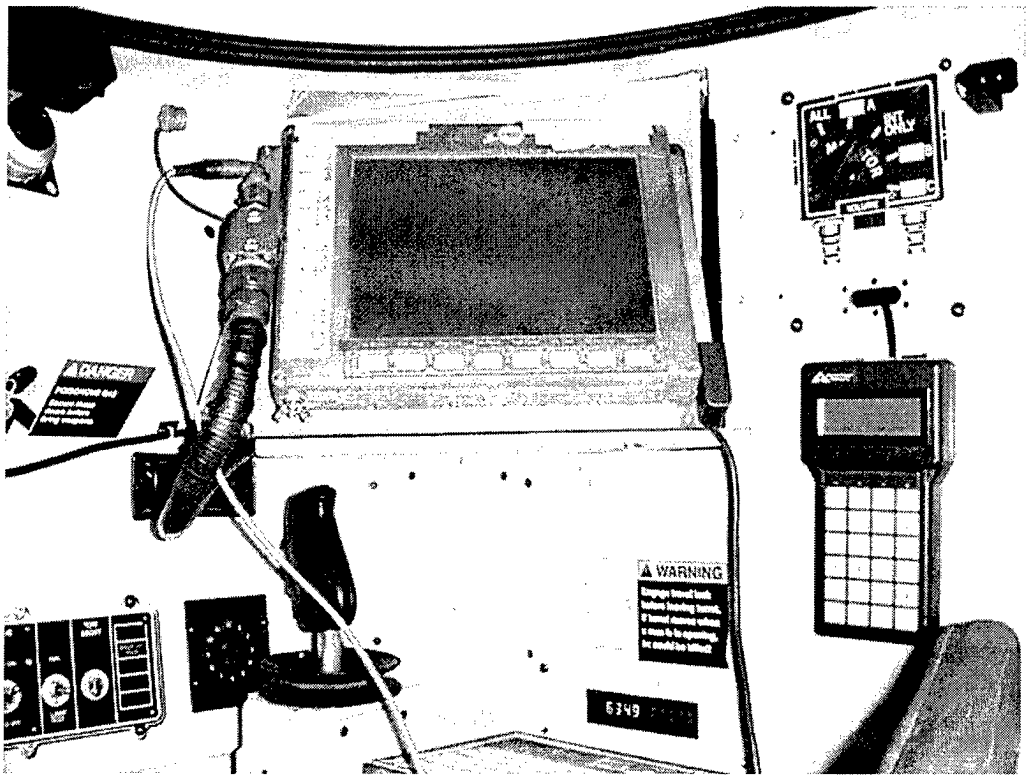

Figure 3-4. M2 Commander Position

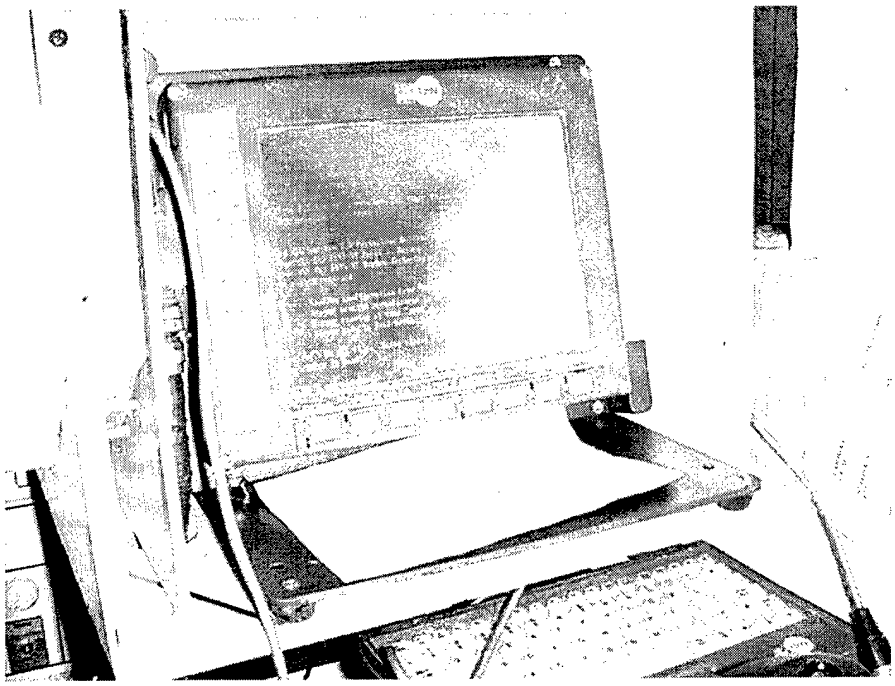

Figure 3-5. M1 Commander Position

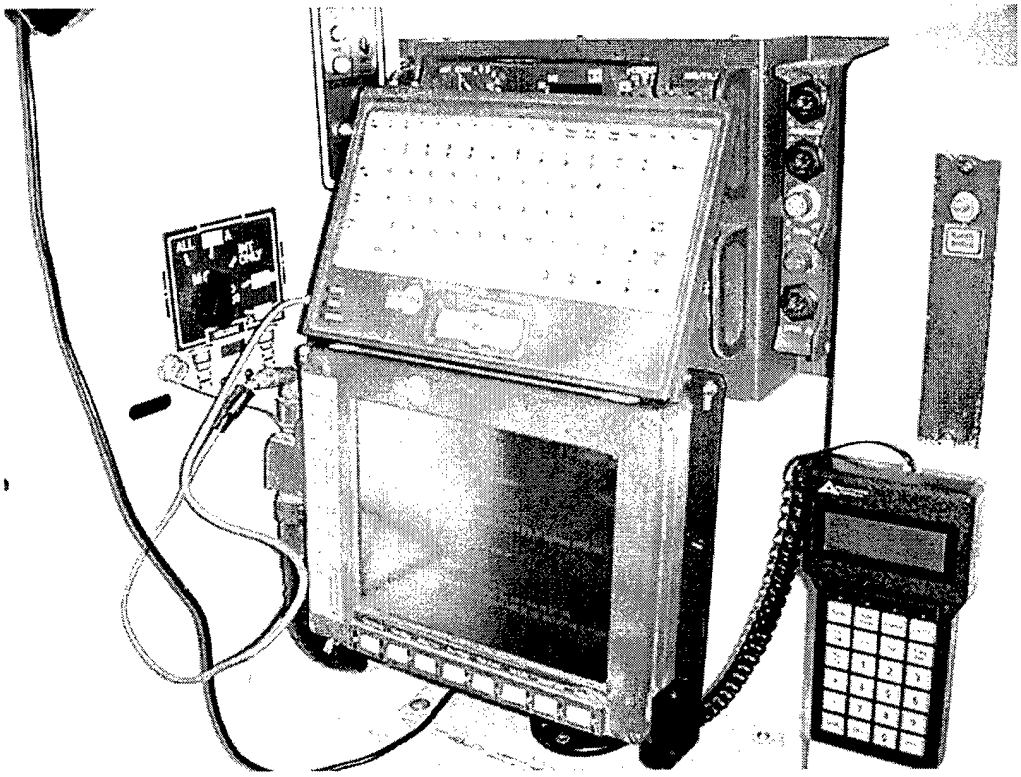

Figure 3-6. M1 Support Position

3.1.2.3 Simulated Radio Communications

The ADST II team utilized ASTI radios to simulate radio communications for use by exercise participants during the experiment. The ASTI hand held terminals are visible in each of the mock-up photos above. The radios were configured for perfect comms. The commanders radio interface was set up for voice activation, i. e. whenever the commander talked it would transmit, without pressing a push to talk switch. This allowed the commander to perform his tasks on the FBCB2 computer and keyboard while talking on the radio. The radio network setups are described in Figures 3-7 and 3-8 below.

	M1 Int	M2 Int	BN1	BN2/DIV	BDE	*Spare*
	101 MHz	102 MHz	30 MHz	31 MHz	32 MHz	33 MHz
M1 CMD	tx/rx		tx/rx		tx/rx	tx/rx
M1 LDR	tx/rx		tx/rx		tx/rx	tx/rx
M1 Gunner	tx/rx		tx/rx		tx/rx	tx/rx
M1 Driver	tx/rx		tx/rx		tx/rx	tx/rx
M2 CMD		tx/rx		tx/rx	tx/rx	tx/rx
M2 LDR		tx/rx		tx/rx	tx/rx	tx/rx
M2 Gunner		tx/rx		tx/rx	tx/rx	tx/rx
M2 Driver		tx/rx		tx/rx	tx/rx	tx/rx
Blue ModSAF 1			tx/rx	tx/rx	tx/rx	tx/rx
Blue ModSAF 2			tx/rx	tx/rx	tx/rx	tx/rx
Ex Control			tx/rx	tx/rx	tx/rx	tx/rx
Observer 1	rx	rx	rx	rx	rx	rx
Observer 2	rx	rx	rx	rx	rx	rx

Figure 3-7. Radio Nets

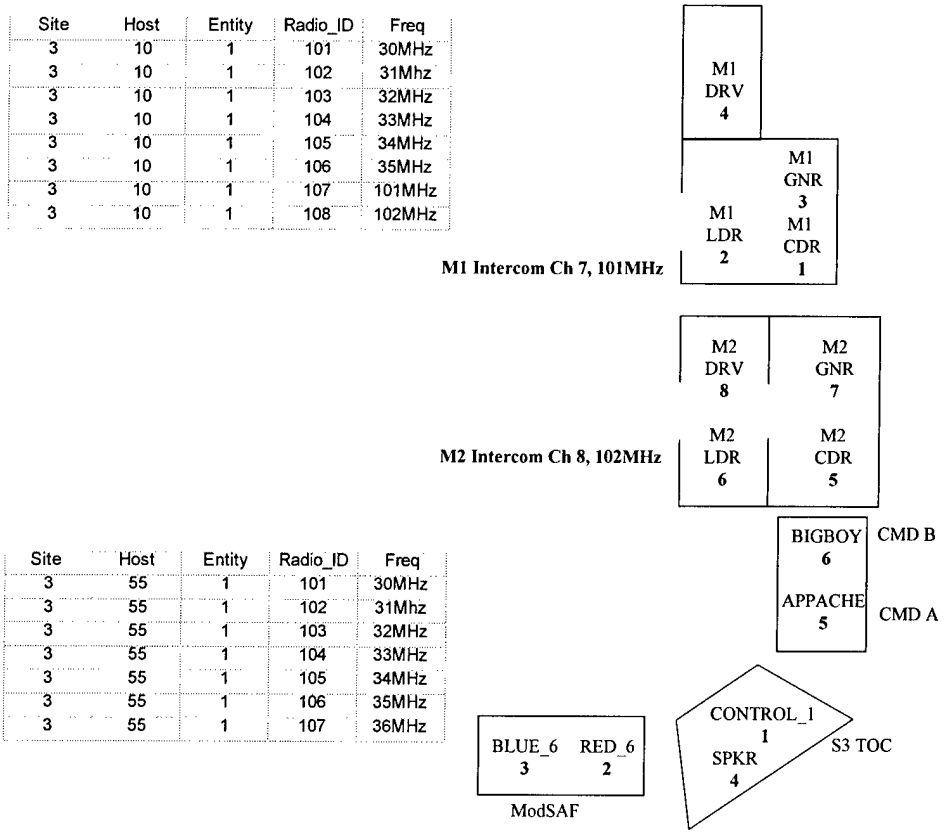

Figure 3-8. Radio Net Layout

3.1.2.4 ModSAF

The ADST II team integrated several ModSAF workstations to provide augmenting friendly (BLUFOR) and opposing (OPFOR) forces for the experiment and to stimulate the FBCB2 situation awareness displays in the simulators. The ModSAF workstations were PCs with Solaris X86 2.6 running ModSAF version 4.0 and DIS protocol 2.04. Figures 3-9 and 3-10 illustrate.

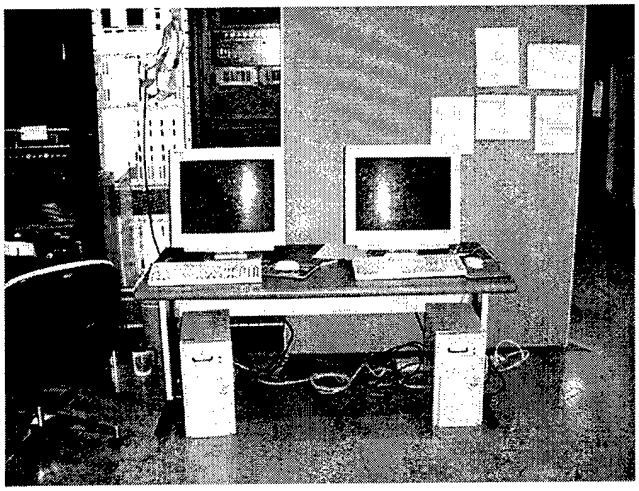

Figure 3-9. ModSAF OPFOR Stations

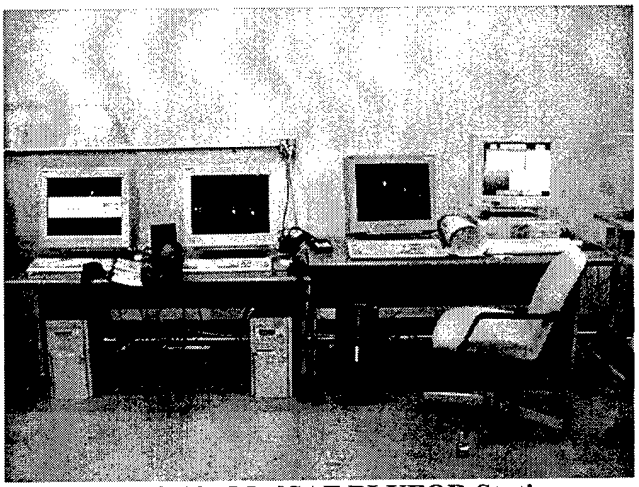

Figure 3-10. ModSAF BLUFOR Stations

3.1.2.5 SATIDS

SATIDS links constructive, virtual and entity-based DIS simulations with C4I devices. SATIDS models the communications effects of the Tactical Internet with voice contention. SATIDS also models virtual C4I systems to support digital messaging in the training environment.

A dual-ported SUN Ultra 2 was used to bridge the SA network and the DIS simulation network. One port of the SATIDS workstation interfaced with the FBCB2 systems, exchanging messages in VMF format. The other port interfaced with the DIS LAN. SATIDS was configured to produce spot reports from DIS packets for all FBCB2s. In addition, the FBCB2s inside the simulators received position updates for their own vehicle icons as their vehicles were moving on the 3-D terrain.

In SATIDS the marking field in the Entity State PDU gets mapped to the C4I 'role' of the vehicle equipped with FBCB2. SATIDS then creates the SA data for this vehicle from other FBCB2 devices on the SA network and from the DIS traffic on the simulation LAN.

General Description

The Situational Awareness Tactical Internet Data Server (SATIDS) models the Tactical Internet (TI) and bridges the simulated environment and real-world Command and Control (C2) devices, such as FBCB2. The SATIDS receives Distributed Interactive Simulation (DIS) Entity State and Signal Protocol Data Units (PDUs) from the manned simulators and ModSAF. This information is used to model the interactions of entity SA and Command and Control data. The server understands that real FBCB2s are on the network and sends them VMF messages. SATIDS provides a way for entities and applications in the DIS environment to send their positions to FBCB2.

SATIDS is a real-time DIS simulation that models realistic SA and C2 message dissemination via the Army's Tactical Internet (TI). The SA data consists primarily of vehicle position reports. SATIDS models the Single Channel Ground and Airborne Radio System, System Improvement Program (SINCGARS SIP +), an upgrade to include a combat identification "don't shoot me" capability through designated communications links. SATIDS models SA data throughputs through the SINCGARS and Enhanced Position Location Reporting System (EPLRS) networks, Precision Lightweight Global Positioning System Receiver (PLGR) and SA/C2 data latencies through the SINCGARS network and the EPLRS message (MSG) servers. SATIDS was designed as an emulator to evaluate the evolving TI architecture and to support man-in-the loop experiments. To incorporate the evolving changes, SATIDS contains a flexible open architecture that will also support growth to the High Level Architecture (HLA) standard. The following requirements were levied on SATIDS by the VIE experiment and FBCB2 DO:

- Positions of ModSAF entities displayed on FBCB2
- Positions of Manned Simulators displayed on FBCB2
- The Tactical Internet to be realistically simulated with delays and dropped messages to FBCB2s (Situational Awareness)
- ModSAF spot and situation reports displayed on FBCB2
- Command and Control messages between FBCB2s be realistically simulated with delays and dropped messages to FBCB2s

FBCB2 provides Situational Awareness (SA) to the user via a continuously updating map. Each FBCB2 is connected to the FBCB2 LAN. UDP packets are used for communications to the FBCB2s over the FBCB2 LAN. FBCB2 uses the LAN interface only for receiving VMF messages from SATIDS. It does not use the LAN for communications between FBCB2s for SA data. FBCB2s do not transmit any Situational Awareness data over the FBCB2 LAN. FBCB2s do transmit C2 data over the FBCB2 LAN if an operator enters and sends a message. The FBCB2s can be configured to send their C2 messages to SATIDS. SATIDS then delays or drops the message and sends any of the remaining messages to the FBCB2.

The PLGR provides time and location to a vehicle's FBCB2 system. Since the vehicle are in a set location a real PLGR can not be used. The SATIDS model tracks every real FBCB2 system being used in the simulation. By tracking the locations of vehicles in the DIS network, the application would provide each FBCB2 their position at a set frequency.

Data used to model the Operational Network (OPNET) can be found in the following document under ADST II Configuration Management: "Laboratory Validation of SIP+ OPNET Model", document # T720979

SATIDS Modifications

No modifications to SATIDS were accomplished under this DO. However, modifications were needed to SATIDS to work the targeted FBCB2 version 3.1F. These modifications were accomplished under DO #104, CTSF Support. Both DO's have the same requirement to work with FBCB2 Version 3.1F. All documentation will be performed under DO #104.

The modifications consisted of upgrading SATIDS to work the FBCB2 JVMF parser 14.14. This is government-furnished software. Then the application was modified to work with the new Tactical Internet architecture. This required a large change in the handling of spot reports in SATIDS.

SATIDS Use

SATIDS was used in the BCV C2 CEP experiment to provide the FBCB2 with Blue SA for all Blue virtual entities (both manned and un-manned). SATIDS also modeled the Observed entity data Messages as in the real world.

SATIDS modeled the Blue SA messages. A new feature was the handling of observed enemy positions. ModSAF entities have the ability to spot the enemy. Since these entities do not have a FBCB2 to report a signal PDU is placed on the simulation network. SATIDS captures this data and converts into a JVMF K05.19 Entity Data message. It then models its flow through the tactical Internet. This modeling results in red icons being displayed on all real FBCB2 in the exercise.

3.1.2.6 Additional Systems

The ADST II team integrated additional systems necessary for successful execution of the experiment. This included:

a) Out-the-window, 3-dimensional "Stealth" view systems (MetaVR). See Figure 3-11.

b) Data loggers to record simulation data and radio communications. Note that the entire network was time synchronized using IRIG-B timestamping and NTP, which insured correct synchronization of all workstations on the network. NTP synchronization proved crucial in the use of FBCB2s in a simulated environment. A special instrumentation PDU was sent out from the ASTI radios, containing the terminal settings and the PTT (push to talk) state of each crewman. The instrumentation PDU was also logged by the datalogger. See Figure 3-12.

c) A video monitoring/capture system was used to monitor the Commander and NCO operating the FBCB2 systems in each vehicle. Two displays were set up per crewman: an over-the-shoulder camera view, and the corresponding FBCB2 view. The video was fed through time inserters and showed the actual experiment time on the display. Both views and the crewman's audio were recorded on two time-synchronized VCRs. See Figure 3-13.

d) Surrogate (PC based) FBCB2 systems used for the White Cell.

e) A dual-ported SGI Indigo2 workstation with IRIX 5.3 was used as a protocol translator, called the XCIAU; it bridged the SIMNET LAN with the DIS LAN.

Figure 3-11. Stealth used for Company Commander's Station

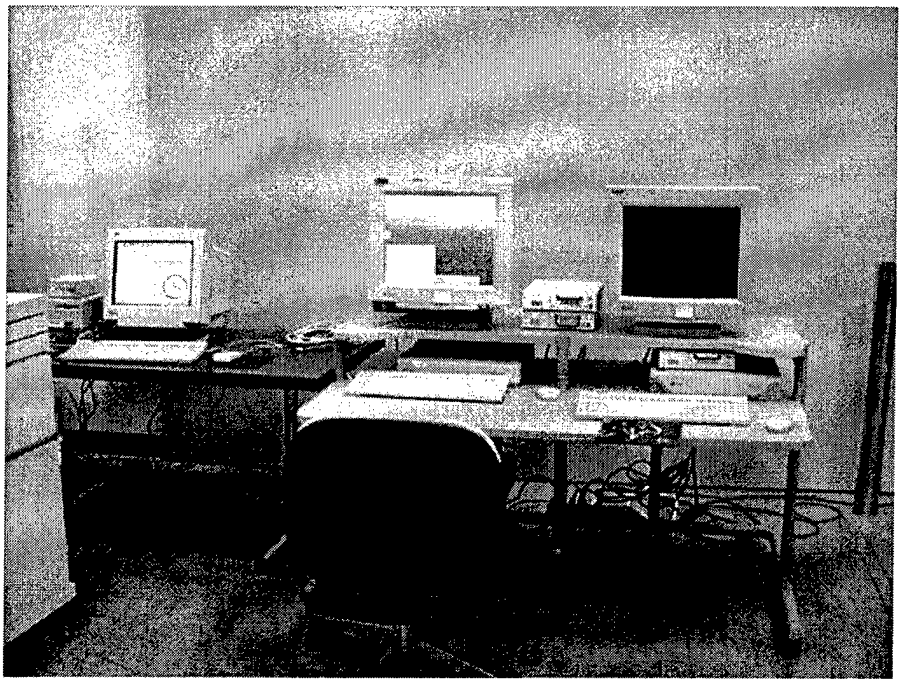

Figure 3-12. Data Collection Station

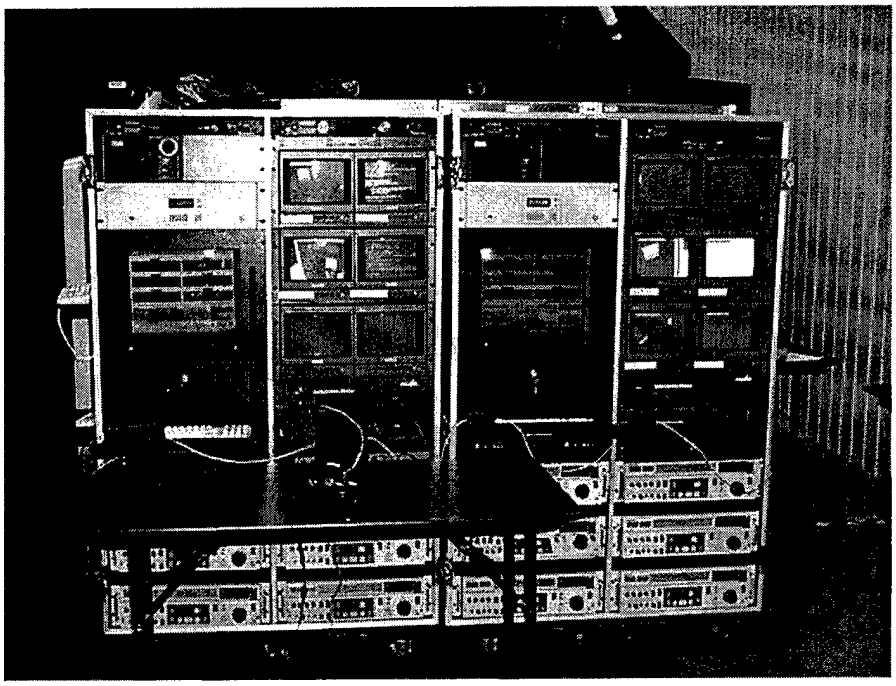

Figure 3-13. Video Capture Station

3.1.3 Application Support

3.1.3.1 Training.

The ADST II team provided training support to player participants and other staff as required.

3.1.3.2 Pilot Test

The ADST II team supported the conduct of a Pilot Test before the start of record runs for the experiment.

3.1.3.3 Execution Support

The ADST II team supported execution of the experiment. Support included:

a) Execution of experiment scenarios via BLUFOR and OPFOR ModSAF.

b) Research Assistant (RA) support (manual data collection, system operation, etc.).

c) Automated data collection.

d) Maintenance of experiment simulation systems.

3.1.4 Follow-On Activities Support

3.1.4.1 Site Reconfiguration

The ADST II team reconfigured all simulation assets to their standard configurations at the conclusion of the experiment.

3.1.4.2 Data Reduction

The contractor worked with the Government to reduce and deliver the automated and manually collected data from the experiment.

3.1.4.3 Final Report

This report is being submitted as the Final Report. It will be revised based on comments received from the Government. (AB01)

3.1.4.4 Software and Software Documentation

As mentioned earlier (paragraph 3.1.2.5), the documentation for SATIDS is provided under DO # 104, since that DO funded the changes required to support this experiment.

3.1.4.5 Capture of Additional Documentation

The data captured during data reduction (see paragraph 3.1.4.2) was provided to MMBL personnel and a copy was placed into CM in the OSF.

3.1.4.6 Support of Follow-on Experiments

No work was performed in this area.

3.2 Deliverables

3.2.1 Contract Data Requirements List (CDRL)

In addition to any required under the basic ADST II contract, the following CDRL items shall be provided in contractor format, and an electronic copy shall be placed in the ADST II Master Library:

a) BCV/CDR's C2S CEP Final Report (CDRL AB01, reference paragraph 3.1.4.3).

b) Experiment Data in the form of an 8mm tape (CM # MD0967).

3.3 Schedule

Work was performed in accordance with the following schedule.

Sep 13 - Sep 17	Experiment Conducted with soldiers
Sep 07 - Sep 10	Pilot Test
Sep 01 - Sep 03	SATIDS Integration with FBCB2 at Knox
Aug 23 - Sep 01	SATIDS upgraded to 3.1.e (work done in Orlando under another DO)
Aug 25	Planning Meeting to review scenario
Aug 04 - Sep 01	FBCB2 equipment integrated